

FOSSIL CREEK NATIVE FISH REPATRIATION PLAN

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BACKGROUND

The Fossil Creek Native Fish Restoration project is a multi-organizational/individual effort to protect and return native fishes to Fossil Creek, Gila–Yavapai counties, Arizona. Environmental compliance, construction of a fish barrier, salvage of remnant native fishes, chemical renovation of the watershed upstream of the fish barrier, and repatriation of salvaged native fishes were completed in early 2005. Except for ongoing monitoring, the major action needed to complete the project as planned is repatriation of threatened or endangered native fishes not specifically known from the stream but within historic range. Such repatriations will significantly advance the recovery process for affected species.

The final environmental assessment for the project (USBR and USFS 2004) called for potential repatriation of seven species listed under the Endangered Species Act (ESA) (Table 1). In addition, several of these species were recommended for repatriation to Fossil Creek by Desert Fishes Team (2003).

Table 1. Species proposed for repatriation to Fossil Creek in the 2004 environmental assessment for the Fossil Creek native restoration project, including their status within the Gila River basin and under ESA.

SPECIES	GILA BASIN STATUS ¹	ESA STATUS
Colorado squawfish <i>Ptychocheilus lucius</i>	extirpated, stocked	endangered
desert pupfish <i>Cyprinodon macularius</i>	extirpated, repatriated	endangered
Gila topminnow <i>Poeciliopsis occidentalis</i>	10 occupied streams ² , repatriated	endangered
loach minnow <i>Tiaroga cobitis</i>	11 occupied streams ^{2, 3}	threatened
razorback sucker <i>Xyrauchen texanus</i>	extirpated, stocked	endangered
spikedace <i>Meda fulgida</i>	8 occupied streams ^{2, 3}	threatened
woundfin <i>Plagopterus argentissimus</i>	extirpated	endangered

¹ Desert Fishes Team (2003)

² Including small streams within larger metapopulation complexes

³ Endemic to the Gila River basin

The purpose of this report is to establish guidelines and criteria to facilitate these repatriations. Although we assess the conservation status of each species and the contribution to that status a repatriation to Fossil Creek would provide, we make no other qualifying statements regarding the appropriateness of any species' translocation to Fossil Creek. The repatriation potential for

some of these species may depend on the condition of habitats that develop and stabilize following flow restoration, which are unknown at this time. Table 2 summarizes the specifics of the repatriation recommendations discussed below.

There is potential that federally-listed species repatriated to Fossil Creek could pass downstream over the constructed fish barrier and enter the Verde River mainstem. Listed fish in the Verde River mainstem may be subject to potential adverse effects that have not been considered in previous biological opinions. As the likely federal "action agency" for repatriation of federally-listed fishes, we recommend the U.S. Fish and Wildlife Service analyze the potential effects of repatriating listed fish species in Fossil Creek through an internal Section 7 ESA consultation. This approach was considered in the Forest Service's Record of Decision on the Fossil Creek native fish restoration project.

BIOLOGICAL AND LOGISTICAL CONSIDERATIONS

Background—The makeup of the historical native fish assemblage in Fossil Creek is imperfectly known. F. M. Chamberlain, a fish biologist with the U.S. Bureau of Fisheries, reported on fishes at the Fossil Springs area in 1904 (Minckley 1999). Using explosives for sampling, Chamberlain found three species of fish (desert sucker, headwater chub, and speckled dace), but his surveys did not extend downstream beyond the vicinity of the springs. Since 1904, other native fishes found in Fossil Creek have included longfin dace, Sonora sucker, and roundtail chub. All six species remain present. Other species listed in Table 1 that were present in Verde River near the mouth of Fossil Creek undoubtedly occurred in the stream, however, the extent (range and abundance) of their presence was not documented and will remain unknown.

Fish habitat in Fossil Creek was significantly altered by construction and operation of the Childs–Irving Hydroelectric Facility shortly following Chamberlain's collections. Nearly all of the stream discharge was diverted into pipes and flumes beginning in 1907, which restricted the amount of surface water available to fish and exposed shallow areas to dessication. In particular, the upper several miles of Fossil Creek were dependent on the steady output of Fossil Springs to maintain the series of dams and other travertine structures that provided a complex of habitats for native fishes. Once the water was diverted, existing travertine structures were destroyed by floods and debris, and the deep cascading pool habitats they had supported were lost. Thus, not only were there limited investigations in Fossil Creek to document the fish assemblage, but the habitats were altered to such an extent that it is probable that native fishes other than those now present were unable to survive.

With restoration of flows due to retirement of the Childs–Irving Hydroelectric Facility, extent of surface water with strong flows and complex currents will increase, and rebuilding of the travertine formations will occur. After a period of a few years, aquatic habitat in Fossil Creek will be significantly different than what is present now. How or even whether these habitats will accommodate additional native fish cannot be known with certainty at this time. However, the assumption is that diverse habitats that can support many, if not all, of the proposed repatriation species will develop and be available for their use.

Genetics—It is impossible to precisely replicate the historical genetic signatures of native fishes that have been lost from Fossil Creek, but introduction of new populations must attempt to restore them as best possible. For most species, foremost consideration is determination of nearest geographic neighbor. This concept assumes that, within major sub-drainages, populations closest to Fossil Creek historically had the highest probabilities of exchanging genetic material with Fossil Creek populations, and therefore would be the most genetically

representative of and presumably best adapted to environmental conditions in Fossil Creek. In the cases of Colorado squawfish and possibly other species, wild populations may be too rare to support direct removal of individuals for translocations, and hatchery stocks are likely the only alternative sources. Specific recommendations for source populations based on the criterion of nearest geographic neighbor or hatchery stock for each species are presented in a later section.

Once the source population has been determined, the next concern is to ensure that stocks repatriated to Fossil Creek reflect the genetic variability of the source populations. This entails capture of a large sample size and avoidance of biased sampling that might skew genetic representativeness. Childs (2005) developed guidelines for such sampling for small-bodied species, which should be followed to the maximum extent possible. When field conditions allow, Childs (2005) suggested selection of approximately equal numbers of males and females, and acquiring a minimum of 100 individuals.

We recommend batch stockings of 200–500 individuals when available, but such decisions must be made on a case-by-case basis to ensure that source populations are not heavily depressed by large collections. When source populations are small, or where sampling conditions cannot otherwise accommodate such collections, re-collections from the source population would be needed over time (Childs 2005). We restate that repeated transplants from source populations across several years should be made, even if initial criteria of Childs (2005) are met. This practice will best ensure a broad genetic sample and a high probability of success of the translocation.

Parasites and disease—Source populations may have come into contact with introduced aquatic organisms that could harbor nonnative parasites or diseases that could then be transmitted to the native Fossil Creek fish assemblage to its detriment. Translocation of introduced pathogens to Fossil Creek should be prevented where possible by conducting a pathogen screening of each source stock, followed by appropriate treatment to eliminate the offending pathogen(s). In some cases, however, if source stocks cannot be cleansed of relatively innocuous pathogens, the translocation should not be necessarily abandoned. In such instances, the potential costs of pathogen introduction versus the potential benefit to each species' conservation status resulting from the translocation must be weighed carefully on a case-by-case basis. The first step should be to identify pathogens already present in Fossil Creek to assist with such decisions, i.e., if the offensive pathogen is already present, there should not be any introduction concerns.

Fish health experts should be consulted prior to each proposed translocation, and an appropriate sample (up to 60 individuals of each species) from the source stock should be screened for presence of pathogens. A brief literature review of known parasites/disease from fishes in the Gila River basin was compiled by Hart (1999). Prophylactic treatment protocols of Childs (2005) should be followed when fish will be transported and/or held in captivity. Presumably the pathogen load of long-held hatchery source stocks are already known and therefore they may not need to be screened. If wild stocks are brought into a hatchery for propagation, these should be screened and treated to eliminate offending parasites and disease.

Repatriation logistics and procedures—Childs (2005) developed protocols for field collections and transport of native fishes to be replicated to the wild or propagated in a hatchery, and proposed hatchery procedures for their quarantine, maintenance, and propagation. These procedures should be followed where possible for repatriation efforts to Fossil Creek. In addition, repatriation actions should release fishes into appropriate habitats (see species recommendations below) in relatively small groups at several localities in relatively close proximity to enhance the probability that individuals can interact and ensure establishment. If

possible, repatriation sites should be within or immediately upstream of areas of slow-moving water or wide floodplains that will enhance the ability of larvae to find quiet marginal habitats for rearing. Such practice also should enhance their ability to withstand flooding events. Group releases should be made in as many areas meeting these criteria as possible to enhance the probability of population establishment. If annual monitoring (see below) fails to find individuals in the areas of initial release, subsequent releases should be made into new areas that meet similar criteria. Finally, fish releases should avoid periods of significant potential flooding and the hottest summer months.

SPECIES RECOMMENDATIONS

Colorado squawfish

Conservation significance—Colorado squawfish was extirpated from the lower Colorado River basin (including the Gila River subbasin) in the 1970s, and 20 years of repatriation attempts have failed to establish a self-sustaining population (Desert Fishes Team 2003). Remaining wild populations in the upper Colorado River basin are relatively small and restricted in distribution, occupying only about 25% of their basin-wide historical distribution (USFWS 2002). Repatriation to Fossil Creek would represent only the third stream in the lower basin where reestablishment has been attempted.

Repatriation source—Wild populations that remain in the upper Colorado River basin are too small to support a direct translocation, and the only alternative is hatchery stocks. Dexter National Fish Hatchery and Technology Center is the recommended source for Fossil Creek. A variety of sizes (larvae, fingerlings, and subadults) should be considered for stocking.

Repatriation habitats—Groups of ~20–50 individuals should be released together into large, deep (>1 m) pools with sufficient cover to support the piscivorous ambush tactics of the species.

Desert pupfish

Conservation significance—Natural populations of desert pupfish have been extirpated from the Gila River basin, and only two populations have been reestablished at wild sites in the basin (Desert Fishes Team 2003). Repatriation and establishment of desert pupfish to a stream the size of Fossil Creek would represent a major step forward toward conservation of this species in the Gila River basin.

Repatriation source—The nearest geographic neighboring natural populations that were identified in the desert pupfish recovery plan for repatriation to the Gila River basin occur in the Rio Colorado delta area of Mexico, and include the El Doctor, Cienega de Santa Clara, Laguna Salada, and Cerro Prieto populations (Marsh and Sada 1993). The first priority repatriation source for Fossil Creek should consider obtaining stock directly from one of these natural populations. Should logistics or politics make that alternative difficult or impossible, stock should be obtained from either the Cibola National Wildlife Refuge headquarters pond (El Doctor replicate), Boyce–Thompson Arboretum (Cienega de Santa Clara replicate), or The Nature Conservancy’s Lower San Pedro River Preserve pond (replicate of the Cibola population).

Repatriation habitats—Groups of ~20–50 individuals should be released together into connected backwaters or relatively shallow (<1 m), quiet habitats along the margins of Fossil Creek in areas with significant floodplain development.

Gila topminnow

Conservation significance—Only about seven natural populations (one representing a metapopulation inhabiting four interconnected streams) of Gila topminnow remain in the Gila River basin (Desert Fishes Team 2003). Despite repatriation attempts to 178 wild locations, only about seven are likely to persist into the foreseeable future (Weedman 2004).

Establishment of a population in Fossil Creek would significantly enhance the conservation status of Gila topminnow.

Repatriation source—Based on the most recent available draft of the revised Gila topminnow recovery plan, possible stock sources for Fossil Creek can include any of the remaining extant wild populations (but not Monkey Springs; see Sheffer et al. 1997), their pure replicates, or any combination of mixed populations (Weedman 2004). We recommend utilization of one of the stocks that has not yet been widely replicated in the wild to large, complex habitats such as Fossil Creek, to best accomplish goals of the recovery plan.

Repatriation habitats—Groups of ~20–50 individuals should be released together into connected backwaters or relatively shallow (<1 m), quiet habitats along the margins of Fossil Creek (including springs and seeps) in areas with significant floodplain development.

Loach minnow

Conservation significance—Loach minnow today is found in fewer than a dozen streams, representing a loss of approximately 85% of its historic distribution (Desert Fishes Team 2003). Successful repatriation to Fossil Creek would constitute the first fully secured replication of a wild population, a significant conservation action as outlined in the loach minnow recovery plan (Marsh 1991a).

Repatriation source—Loach minnow has not been collected from the Verde basin for many decades, and a recent comprehensive survey of isolated but potentially suitable stream habitats in the Verde River drainage failed to disclose any extant populations. Since there are no known populations extant in the Verde River drainage, the nearest geographic neighbor would be either the North Fork of the East Fork Black River, White River, East Fork White River, or North Fork White River populations. We recommend using one of the White River populations for translocation to Fossil Creek to ensure this largely unstudied metapopulation is replicated and can be examined genetically. A request to the U.S. Fish and Wildlife Service Pinetop Fisheries Resources Office has been made for obtaining stock from one of the White River White Mountain Apache Nation (WMAT) populations.

Absent timely cooperation from WMAT, North Fork of the East Fork Black River population (Apache–Sitgreaves National Forest) should be utilized as the source stock for a Fossil Creek translocation. Should that source also be infeasible, the Aravaipa Creek population would be the tertiary priority population based on the nearest geographic neighbor concept.

Repatriation habitats—Groups of ~20–50 individuals should be released together into rocky riffle habitats, or into the lower ends of pools immediately upstream of such riffles.

Spikedace

Conservation significance—Spikedace today is found in only eight streams, representing a loss of approximately 85–90% of its historic distribution (Desert Fishes Team 2003). Successful repatriation to Fossil Creek would constitute the first fully secured replication of a wild population, a significant action as outlined in the spikedace recovery plan (Marsh 1991b).

Repatriation source—One of the primary purposes for barrier construction and renovation of Fossil Creek was to replicate the Verde River population of spikedace. That population is rare to the point that it has not been detected since the late 1990s. However, the spikedace has had a history of peaks and valleys in abundance in the Verde River and elsewhere. Expanded attempts to find the species in the Verde River are in progress, and assuming that the species is found, all captured individuals (up to 500) should be taken to Bubbling Ponds Hatchery to establish a captive population and initiate propagation according to goals and protocol outlined by Childs (2005). Once adequate numbers (several hundred) of progeny become available from the hatchery to both sustain the captive population and support a release to the wild, they should be repatriated to Fossil Creek.

If attempts to collect spikedace from the Verde River following directed attempts by knowledgeable individuals over several years fail, we recommend using the Aravaipa Creek population of spikedace as the next nearest geographic neighbor. Assuming Aravaipa populations remain healthy and abundant as they are currently, we recommend a spikedace translocation directly from Aravaipa Creek to Fossil Creek.

Repatriation habitats—Groups of ~20–50 individuals should be released together into relatively shallow (<1 m) habitats in shear zones along gravel sand bars, quiet eddies on the downstream edge of riffles, broad shallow areas above gravel sand bars, or to shallow pools adjacent to these habitats.

Razorback sucker

Conservation significance—Wild populations of razorback sucker have been extirpated from the Gila River basin. Although nearly 12 million razorbacks (mostly larvae and fingerlings) have been repatriated into a variety of waters in the Gila River basin since 1981, none appear to have persisted beyond a few years, and there has been no evidence of successful reproduction. Fossil Creek was stocked with several thousand razorback suckers in the 1980's. A small group of them survived in Fossil Springs above the diversion dam at least until the late 1990's, although none have been found during cursory surveys since then. The repatriation attempt to Fossil Creek proved one of the longest-surviving, and therefore should be repeated. Careful analysis of habitats that will potentially develop in Fossil Creek strongly suggests that certain life stages of razorback sucker (larvae, fingerlings, and subadults) will do well in the stream, and may help reestablish downstream populations in Verde River.

Repatriation source—The nearest geographic neighbor is Lake Mohave, AZ–NV, which has been the subject of intensive efforts to replace the senescent wild population with wild-caught progeny reared in protected habitats. The Lake Mohave population also has been shown to exhibit the greatest amount of genetic variation among known populations (Dowling et al. 1996), and the progeny repatriated back to the reservoir adequately reflect the parental genetic diversity (Dowling et al. 2005). Use of progeny from this population is the preferred source for translocation, which would entail collection of wild larvae from Lake Mohave followed by subsequent rearing in a protected habitat prior to stocking to Fossil Creek. A variety of sizes (larvae, fingerlings, and subadults) should be considered for stocking. If such stock cannot be obtained, translocation sources of razorback sucker for Fossil Creek should next consider hatchery fish from either Dexter National Fish Hatchery and Technology Center, Bubbling Ponds Hatchery, or other hatcheries that propagate or hold the species.

Repatriation habitats—Groups of ~20–50 individuals should be released together into large, deep (>1 m) pools.

Woundfin

Conservation significance—Wild populations of woundfin have been extirpated from the Gila River basin. Although four efforts to repatriate the species to the Gila River basin were attempted, none succeeded (Desert Fishes Team 2003). Successful repatriation to Fossil Creek would constitute the first replication of the species outside its present range in the mainstem Virgin River, AZ–NV–UT (USFWS 1994), and would significantly elevate its conservation status.

Repatriation source—If timed right, it is possible the Virgin River population could support a direct translocation to Fossil Creek. If not, the captive population established in 1988 at Dexter National Fish Hatchery and Technology Center would be the backup source, which presumably could support a direct translocation. A third alternative would be to establish a captive population at Bubbling Ponds Hatchery for repatriation efforts to the Gila River basin.

Repatriation habitats—Groups of ~20–50 individuals should be released together into runs and quieter waters adjacent to riffles with sand/gravel substrates.

MONITORING

A five-year fish monitoring program for Fossil Creek has been contracted, which can be modified to incorporate additional specific monitoring for newly repatriated fishes. Such monitoring should be conducted at least annually using non-lethal sampling methods, accompanied by written reports documenting the distributions and population/reproductive status of repatriated species, with recommendations for modifying future repatriation protocol as necessary.

Table 2. Suggested population sources (in order of priority) from which to acquire stocks to repatriate native fishes to Fossil Creek, Arizona, with description of habitats where species should be released.

Species	Population source	Primary release habitat
Colorado squawfish	1. Dexter NFHTC	large, deep pools with cover
desert pupfish	1. Any of four Rio Colorado delta populations 2. Cibola NWR headquarters pond, Boyce-Thompson Arboretum, or TNC Lower San Pedro Preserve	connected backwaters or quiet marginal habitats in areas of wide floodplain
Gila topminnow	Any of eight extant wild populations or their replicates, but not Monkey Spring	connected backwaters or quiet marginal habitats in areas of wide floodplain
loach minnow	1. White River/N Fk/E Fk 2. N Fk E Fk Black River 3. Aravaipa Creek	rocky riffles
razorback sucker	1. Lake Mohave progeny 2. Dexter NFHTC or Bubbling Ponds Hatchery	large, deep pools
spikedace	1. Verde River 2. Aravaipa Creek	shear zones adjacent to bars, eddies downstream of riffles
woundfin	1. Virgin River 2. Dexter NFHTC	runs and quiet waters adjacent to riffles

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